

CLAIMS

1. A process for liquefying starch-containing material comprising treating said starch-containing material with at least one alpha-amylase and a maltogenic amylase.

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2. A process for liquefying starch-containing material comprising treating said starch-containing material with at least one amylase and at least one esterase.

3. The process of claim 2, wherein the liquefaction comprises:

10 (a) pre-treating a slurry of said starch-containing material with at least one esterase, and

(b) liquefying the pre-treated slurry with at least one alpha-amylase.

15 4. The process of any of claim 1-3, wherein the starch-containing material is reduced in size, preferably by dry milling.

5. The process of claim 3, wherein further a maltogenic amylase is present during pre-treatment.

20 6. The process of claim 2, wherein the pre-treatment is carried out by subjecting the slurry of starch-containing material with an esterase, preferably a lipase, a maltogenic amylase and an alpha-amylase, preferably an acid amylase, such as a fungal acid alpha-amylase.

25 7. The process of claim 3, wherein the amylase is a maltogenic amylase and/or an alpha-amylase.

30 8. The process of claim 1, wherein the liquefaction is carried out in multi-stages, such as three stages, preferably a first stage at a temperature in the range from 80 to 105°C, a second stage at a temperature in the range between 65 to 95°C, and a third stage at a temperature between 40-75°C.

35 9. The process of claim 8, wherein the multi stage liquefaction is carried out at the following temperature stages: a first stage: 80-95°C, a second stage: 75-85°C, and third stage: 60 to 70°C.

10. The process of claim 8 or 9, wherein the holding time for stage one is 10 to 90 minutes, 30-120 minutes for the second stage and 30-120 minutes for the third stage.

11. The process of any of claims 1-10, wherein the starch-containing material is treated
5 with an esterase and a maltogenic amylase and/or an alpha-amylase.

12. The process of any of claims 1-11, wherein the starch-containing material is whole grains, preferably corn, wheat, barley, or milo.

10 13. The process of any of claims 1-12, wherein the amylase or maltogenic amylase is of bacterial origin, preferably a strain of the genus *Bacillus*, especially *Bacillus stearothermophilus*.

14. The process of any of claims 2-13, wherein the esterase is a lipase, phospholipase,
15 or a cutinase, or a combination thereof.

15. The process of any of claims 1-14, wherein liquefaction is carried out in the presence of a fatty acid oxidizing enzyme, preferably a lipoxygenase.

20 16. The process of any of claims 1-15, wherein the (pre-)treatment is carried out in an aqueous slurry at a temperature in the range from 20-105°C, preferably 60-95°C.

17. A process for producing a fermentation product, comprising

25 (a) reducing the size of starch-containing material;
(b) liquefying the product of step (a) with at least one alpha-amylase and at least one maltogenic amylase as defined in claim 1;

(c) saccharifying the liquefied material obtained in step (b) with a carbohydrate-source generating enzyme; and

30 (d) fermenting the saccharified material using a fermenting microorganism.

18. A process for producing a fermentation product, comprising

(a) reducing the size of starch-containing material;
(b) liquefying the product of step (a) with at least one amylase and at least one esterase;

35 (c) saccharifying the liquefied material obtained in step (b) with a carbohydrate-source generating enzyme; and

- (d) fermenting the saccharified material using a fermenting microorganism.
19. A process for producing a fermentation product, comprising
(a) reducing the size of starch-containing material
5 (b) i) pre-treating a slurry of said starch-containing material with at least one esterase,
ii) liquefying the pre-treated slurry with an alpha-amylase;
(c) saccharifying the liquefied material obtained in step (b) with a carbohydrate-source generating enzyme; and
10 (d) fermenting the saccharified material using a fermenting microorganism.
20. The process of any of claims 17-19, wherein the starch-containing material is reduced in size by dry milling.
- 15 21. The process of any of claims 17-20, wherein steps b) and c) are carried out as a simultaneous saccharification and fermentation step (SSF).
22. The process of any of claims 17-20, wherein the starch-containing material is whole grains, preferably corn, wheat, barley, or milo.
- 20 23. The process of claim 19, wherein the pre-treatment in step (b) i) is further carried out in the presence of a maltogenic amylase.
- 25 24. The process of any of claims 17-23, wherein the carbohydrate-source generating enzyme is a glucoamylase or an alpha-amylase of mixtures thereof, preferably in mixture of acidic fungal alpha-amylase activity (AFAU) per glucoamylase activity (AGU) (AFAU per AGU) of at least 0.1, in particular at least 0.16, such as in the range from 0.12 to 0.50.
- 30 25. The process of any of claims 17-24, further comprising distilling the fermented material.
26. The process of any of claims 17-25, wherein said fermenting microorganism is yeast.
- 35 27. The process of any of claims 17-26, wherein the treatment or pre-treatment is carried out in aqueous slurry at a temperature in the range from 20-105°C, preferably 60-95°C.

28. The process of any of claims 19-27, wherein further a maltogenic amylase is present during pre-treatment.

29. The process of any of claims 19-28, wherein the pre-treatment is carried out by
5 subjecting the slurry of starch-containing material with an esterase, preferably a lipase, a maltogenic amylase and an alpha-amylase, preferably an acid amylase, such as a fungal acid alpha-amylase.

30. The process of any of claims 19-29, wherein the amylase is a maltogenic amylase
10 and/or an alpha-amylase.

31. The process of any of claims 17-30, wherein the liquefaction is carried out in multi-stages, such as three stages, preferably a first stage at a temperature in the range from 80 to 105°C, a second stage at a temperature in the range between 65 to 95°C, and a third
15 stage at a temperature between 40-75°C.

32. The process of claim 31, wherein the multi stage liquefaction is carries out at the following temperature stages: a first stage: 80-95°C, a second stage: 75-85°C, and third stage: 60 to 70°C.
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33. The process of claim 31 or 32, wherein the holding time for stage one is 10 to 90 minutes, 30-120 minutes for the second stage and 30-120 minutes for the third stage.

34. The process of any of claims 17-33, wherein the starch-containing material is treated
25 with an esterase and a maltogenic amylase and/or an alpha-amylase.

35. The process of any of claims 17-34, wherein the starch-containing material is whole grains, preferably corn, wheat, barley, or milo.

30 36. The process of any of claims 17-35, wherein the amylase or maltogenic amylase is of bacterial origin, preferably a strain of the genus *Bacillus*, especially *Bacillus stearothermophilus*.

35 37. The process of any of claims 18-36, wherein the esterase is a lipase, phospholipase, or a cutinase, or a combination thereof.

38. The process of any of claims 17-37, wherein liquefaction is carried out in the presence of a fatty acid oxidizing enzyme, preferably a lipoxygenase.

39. The process of any of claims 18-38, wherein the (pre-) treatment is carried out in an
5 aqueous slurry at a temperature in the range from 20-105°C, preferably 60-95°C.

40. The process of any of claims 17-39, wherein the fermentation product is ethanol.